



# **GLOBE ONE: Partnering Students and Scientists to Study the Interaction Between Land Use and the Environment**

GLOBEone

## Introduction

The GLOBE ONE field campaign was developed by GLOBE science PIs with the help of the GLOBE Program Office to demonstrate the capability of GLOBE student-teacher-scientist partnerships to produce scientific results publishable in refereed journals. The central scientific objective is to compare quantitatively the environmental effects of various soil tillage techniques. This field campaign will involve a first hand partnership between students and scientists to collect a structured, multidisciplinary data set that will not only address the research question, but will also increase GLOBE visibility.

The science objectives of GLOBE ONE involve comparing the environmental impacts of tillage techniques used in agriculture. Specifically, we will investigate the impacts associated with varying the frequency and intensity of soil tillage and with varying the amount of crop residue left after crops are planted. Tillage is a manipulation of soil by physical means to create soil conditions suitable for plant growth (Gajri et al., 2002).

The multidisciplinary perspective that GLOBE ONE will apply to assess the environmental impacts of an alteration in land management practices will be key in assessing the environmental impacts.

Black Hawk County, Iowa, will be the location of the field campaign. Black Hawk County has the required field sites. In addition, it is also home to one of GLOBE's outstanding partners, Marcy Seavey, who has already begun building a network of capable schools and community resources for this project. There are already schools in the County with outstanding records for contributing GLOBE.

The bulk of data collection for this project will be performed by GLOBE students collaborating with scientists. GLOBE ONE and GLOBE Iowa will supply an infrastructure for community and partner aid to the GLOBE schools and supplement measurements when required. Since this field campaign will directly involve students in a scientific investigation, it will be a clear demonstration of GLOBE's capabilities. It will not only address the immediate pressing need for providing a complete GLOBE dataset and strong publication record but will also provide a model on which future scientific partnerships involving GLOBE students, teachers, and scientists can be based.

## Goals and Objectives

By focusing the scientific procedures that exist in GLOBE for a structured research project, we will be able to accomplish a variety of GLOBE ONE goals, namely:

1) Science Goals:

1. Produce scientific publications based on GLOBE data addressing the central scientific objective of GLOBE ONE, namely: assessing the impact of farming practices, prairies, and other LULCs on the local environment. More specifically, the following hypotheses will be addressed in the context of Black Hawk County, Iowa

- b. In addition to measurements that directly address the above hypotheses, additional “piggy back” measurements will take advantage of the other measurements and critical mass of participants to assess:
  - a. The effects of weather and surrounding land use patterns on the seasonal arrival and behavior of ruby-throated hummingbirds
  - b. The effects of snow cover on satellite-based aerosol retrieval
  - c. The effects of snow cover on satellite contrail and cloud measurements.

Although less closely tied to the central objectives, these questions and related measurements are of interest to local teachers in addition to contributing to scientific publications.

2) GLOBE Science/Education Partnership and Infrastructure Goals

- a. Establish a Learning Community where multiple community entities collaborate to collect data
- b. Foster student research, providing an environment for the creation of excellent reports for the GLOBE Student Investigation Page
- c. Partner students and scientists in a collaborative relationship to answer relevant science questions.
- d. Give GLOBE a major selling point in reaching out to the agricultural education community, a great potential partnership that has yet to be fully realized.
- e. Build a model for other such projects involving GLOBE protocols and schools.
- f. Generate publicity that will aid GLOBE in its fundraising efforts
- g. Partner students and scientists in a collaborative relationship to answer a relevant scientific question – the GLOBE ideal.

Research Question and Scientific Background

Through GLOBE ONE, we propose to investigate the environmental impacts of the land surface. In Iowa, this requires a focus on corn and soybeans, and agricultural tillage techniques that vary the frequency and intensity of soil tillage and the amount of crop residue left after crops are planted. We will attempt to answer the question:

*For corn and soybeans, what are the environmental impacts associated with different frequencies and intensities of soil tillage farming, and with different amounts of crop residue left after planting as compared to prairie and urban sites?*

Tillage is used to prepare the soilbed for the planting of seeds and to remove weeds and residue left over from previous plantings. It serves to eliminate weeds, manage residues, integrate fertilizers, improve heat transfer, and aerate the soil (Gajri et al., 2002). Gajri,

*et. al.* explain that soil tillage “is known to affect productivity and all aspects of environmental quality significantly” (p 1).

Tillage has been practiced for about as long as humans have domesticated and cultivated plants (Gajri et al., 2002). Early on, fingers and sticks were used to scratch soil surfaces. Then plow animals were used to drive tools that could till upper layers of soil. Now fossil fuel driven equipment makes it possible to till soil to depths of over a meter (Gajri et al., 2002).

Removing crop residue from the surface of a field makes it easier to plant seeds and aids certain plants in sprouting. However, the presence of plant residue helps to reduce erosion and improves structural stability of soil, so removing residue can increase the loss of soil (Koller, 2003). The presence of plant residue also affects soil by lowering the temperature, increasing moisture, lowering aeration, increasing density, increasing organic matter (Uri, 1999-1). Residue also provides shelter and food for certain species so can benefit wildlife (Uri, 1999-2).

In 1960, about two percent of the planted land in the United States was farmed using conservation tillage techniques. This rose to 36 percent by 1996 (Uri, 1999-2). Conservation tillage refers to any tillage practice that leaves at least 30% of the soil surface covered with crop residue after planting (Koller, 2003). In areas in which wind erosion is a major concern, a small grain residue equivalent may be used during the period of critical concern (Gajri et al., 2002). This tillage practice evolved from a practice of simply using fewer trips across the field. In between conventional tillage and conservation tillage there exists the practice of reduced tillage in which the soil is tilled to some degree and 15-30% of the soil surface is covered with crop residue after planting (Gajri et al., 2002).

Another important emerging tillage practice is no-tillage in which the soil is not physically disturbed from harvest to planting (Koller, 2003). The amount of crop residue left at the time of planting can be varied with no-tillage. When no-tillage is practiced with greater than 30% of the land covered by crop residue after planting it is a form of conservation tillage. When less than 30% of the land covered by crop residue after planting it stands as a separate tillage practice.

The conservation tillage and no-tillage sites looked at in this study will involve row-crop farming of predominantly corn and soybean monocultures. They will alternate seasonally between corn and soybeans. Environmental impacts include the effects on local weather and soil properties, and the effects on nearby streams as assessed through examination of macroinvertebrate populations and chemical and physical properties of the water.

There are a myriad of factors that affect decisions regarding frequency and intensity of tillage applied to, and amount of crop residue retained on, a given field. One of these factors is the environmental impact that will result. We aim to quantify this impact to aid in making decisions that assure optimal agricultural techniques are being practiced.

### A Unique Collaboration of Educators and Scientists

The GLOBE ONE field campaign will be conducted through a collaboration between students, teachers and scientists. A key component to GLOBE science is the group of 11 Principal Investigator-led (PI) teams sponsored by the National Science Foundation (NSF), with active participation by members of the Science Team at the GLOBE Program Office. The participating students and teachers will have a remarkable opportunity to work directly with these scientists, and obtain an inside view of a major research campaign. GLOBE ONE will feature measurements taken by students with the oversight and support of scientists. Both students and scientists will analyze the collected data to help answer research questions.

The benefits to both students and teachers of having scientists involved in K-12 classrooms have been documented by many researchers in a wide variety of programs (Claudio, 2001; Grayson, 2001; King & Bruce, 2003; Owens, 2000). Students' attitudes toward the nature of science as well as their view of the profession are greatly affected. One of the goals of the GLOBE Program is to increase the potential number of students pursuing science as a career. The involvement of GLOBE ONE Principal Investigators and local scientists with the schools may have tremendous impact on the accessibility of science as a career choice in addition to the overall attitude students have toward the nature of science. The National Science Education Standards for Professional Development of teachers include involving teachers in authentic research as a means of improving science education in their classroom. Teachers who have had research experience can positively affect the environment for learning science in their classrooms (Caton et al., 2000; Johnson, 2002; Odom, 2001). Teachers and their students in GLOBE ONE will contribute to real science investigations of the effects of land use change on components of the Earth System.

We will promote student use of GLOBE ONE data. Students who participate in GLOBE ONE will be encouraged to ask science questions and develop independent research projects. Our scientists and partners will aid them in structuring these projects and performing data analysis and modeling. Student reports generated as part of GLOBE ONE will be submitted to the *GLOBE Student Investigations Journal*, where they will be made available to the public. Additional existing GLOBE tools for supporting student investigation, such as science background material given in the Teacher's Guide and the *Looking at Your Data* sections of protocols, will also be used in support of GLOBE ONE student research. The GLOBE Program is uniquely structured and qualified to support first-hand involvement of students in scientific research. This has been the main focus of the Program, since its inception in 1994. The 104 countries that participate in GLOBE have reported over 10 million student measurements. All data are publicly available, and a variety of access tools have been designed to aid in the use of these data for scientific investigations.

Past evaluations of the GLOBE program have concluded that there are some common elements to successful implementation of GLOBE into the curriculum (Penuel, 2003). These elements include professional development for teachers, support for data collection, authentic community based research projects, alignment to education

standards, and administrative support. The design of the education component of GLOBE ONE addresses each of these elements. GLOBE ONE professional development calls for several meetings over a period of time with most taking place on site. This type of professional development as opposed to one time off site seminars and workshops is far more effective (CEO Forum, 1999; Garet et al., 2001). Continuous, reliable data collection is one of the keys to the success of the GLOBE ONE project. GLOBE ONE has incorporated the SRI recommendations associated with high levels of data reporting into its program. These include teachers' participation in mentoring and on-site activities, use of participation incentives, and use of supplementary educational materials provided by partners (Means et al., 2001). Technology supported learning activities have a great potential for providing relevance and meaning for young people (Means, 1998; Means, Penuel, & Padilla, 2001). In GLOBE ONE, the presence of local scientists as well as GLOBE PI's emphasizes the importance of the research that the students will be doing. Previous studies have shown that GLOBE students make varying degrees of connections between their data collection and the larger project (Means et al., 2000). GLOBE ONE ensures that the connection between GLOBE data collection and the research question will be obvious. The alignment to the NSES standards for IOWA begun by Bill Penuel and Marcy Seavey is a key to providing support at the school, district, and state administrative levels. GLOBE ONE has also received administrative support at the building-, district, and state-levels, which are critical for the adoption of this innovative program by teachers (Fullan, 1991).

The educational benefits of GLOBE ONE will extend well beyond the students and teachers that are directly involved. GLOBE plans to publicize the research design and results both internally and externally. Reports will be circulated to the GLOBE community detailing GLOBE ONE's progress. GLOBE ONE will improve student understanding of science by following the best practices of GLOBE. It will involve students in performing real science, taking measurements, analyzing data, using models, and participating in research in collaboration with scientists.

### Conclusions

The GLOBE ONE Field Campaign will serve to show best practices in the application of the GLOBE Program. Ideally, this will serve as a model for future applications of the program.

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